CAT Cement Sub-Group GHG Reduction Strategies

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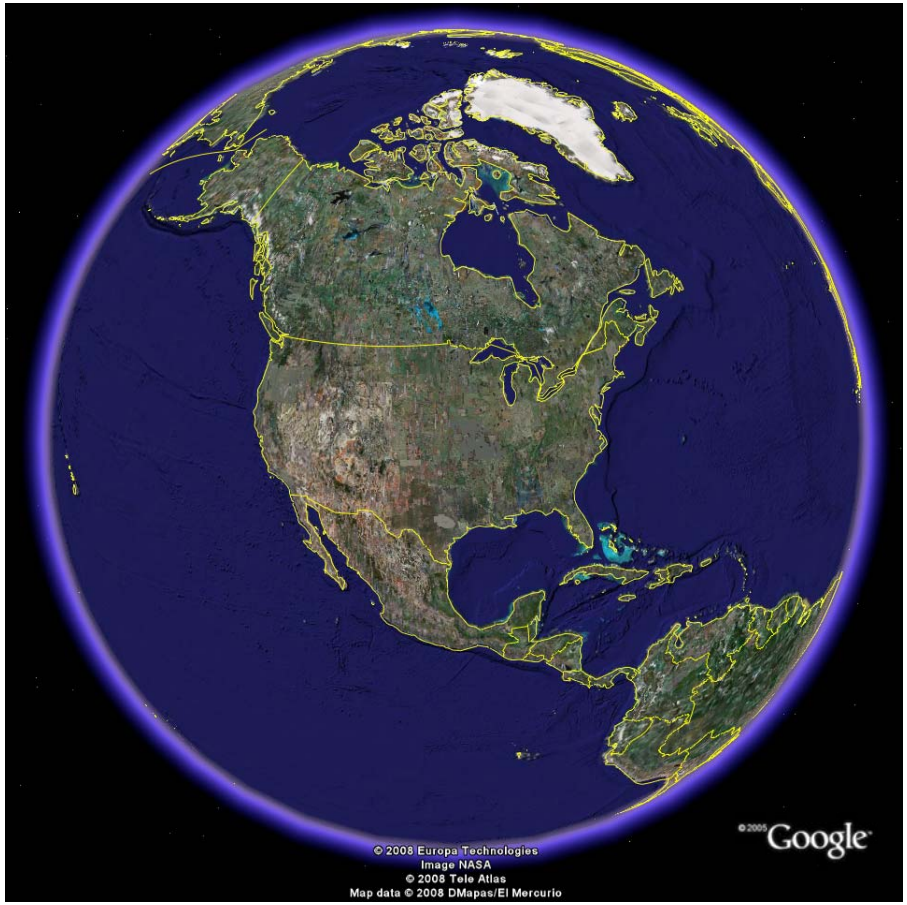
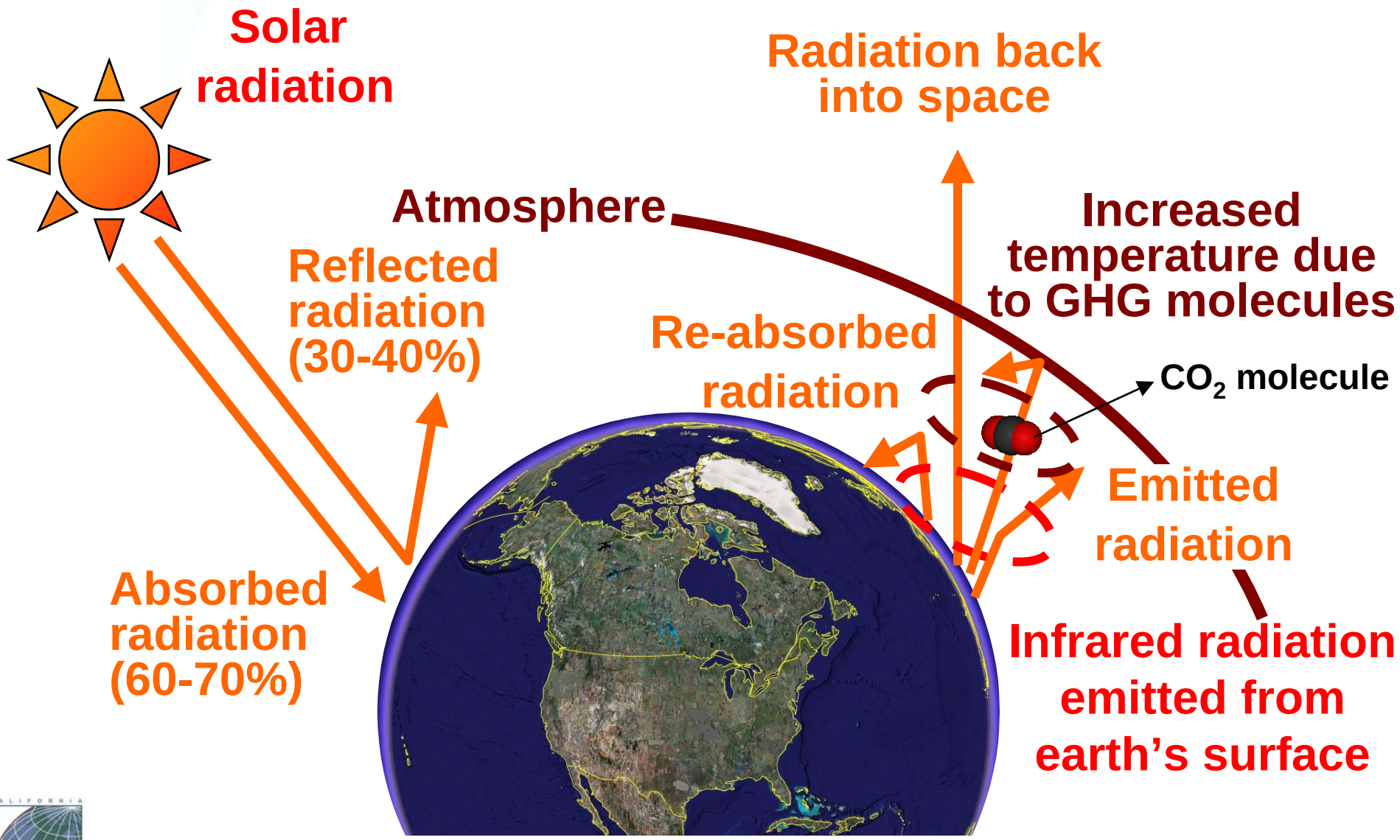
CAT Cement Sub-Group Leader

What causes climate change?

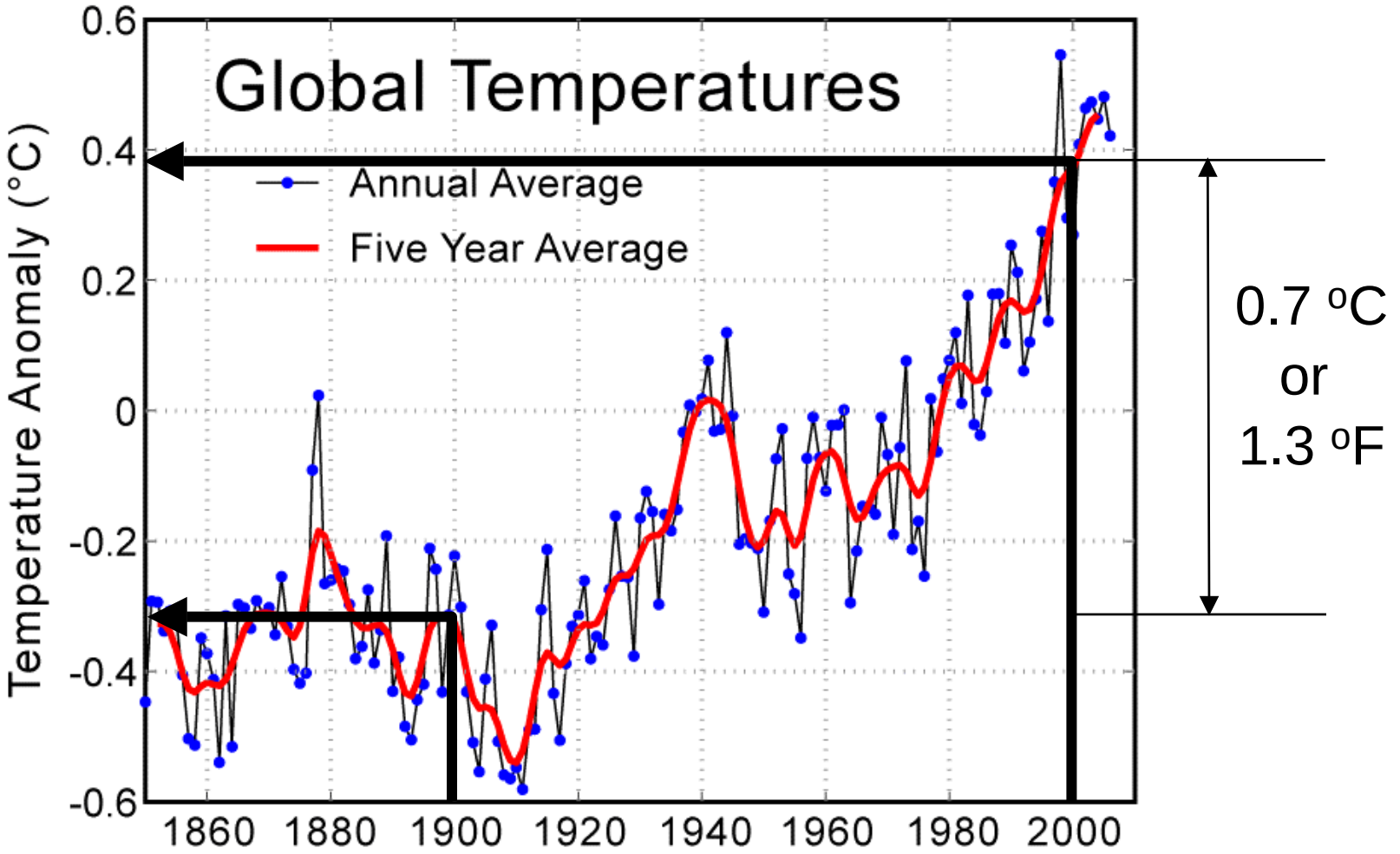
- Increase in Earth's **temperature** due to **greenhouse gas (GHG)** effect.



What is the GHG effect?



How much has the global temperature increased in the last century?



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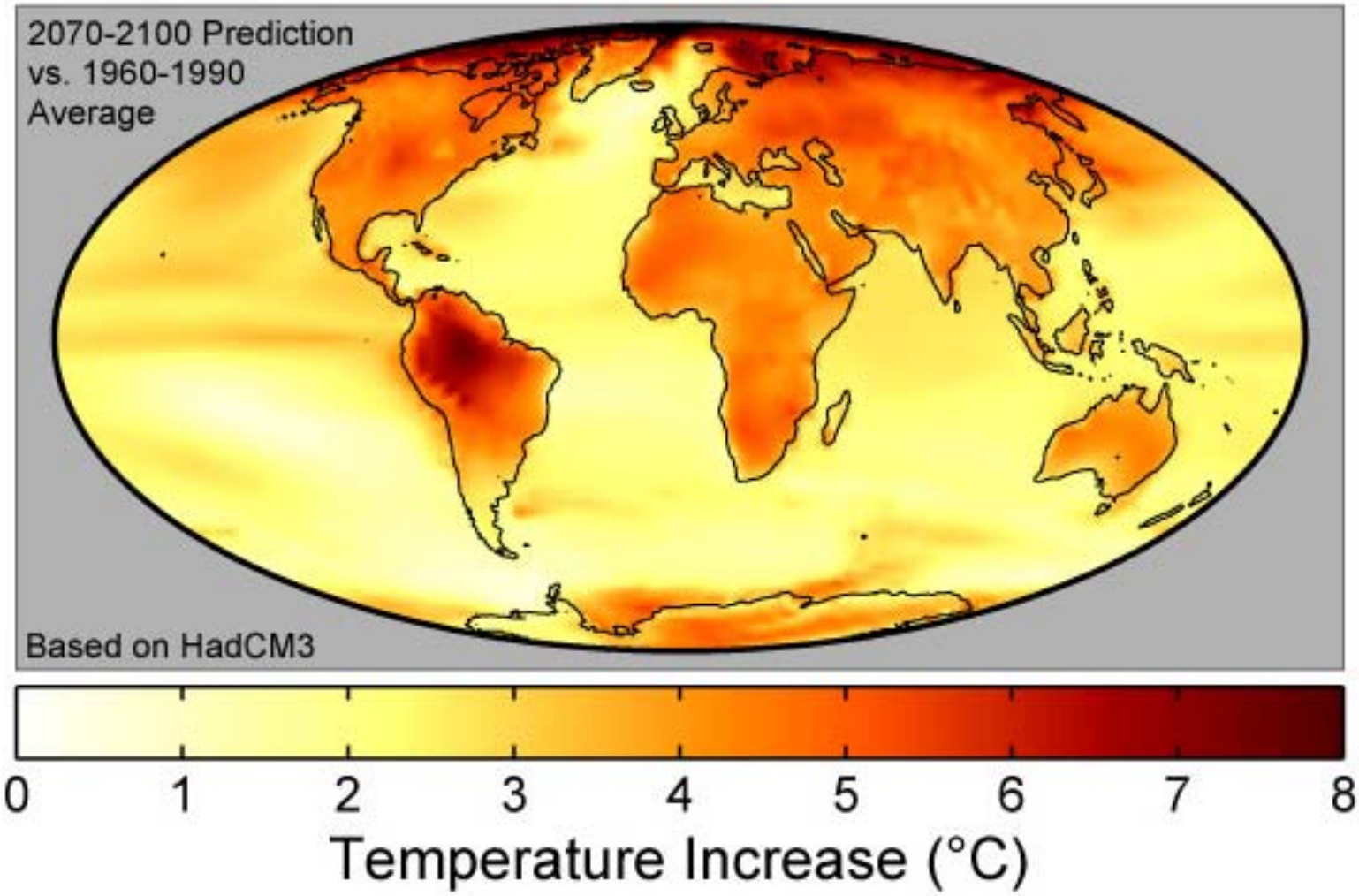
Source: Global Warming Art (2008).

What is the estimated global temperature increase in the next century?



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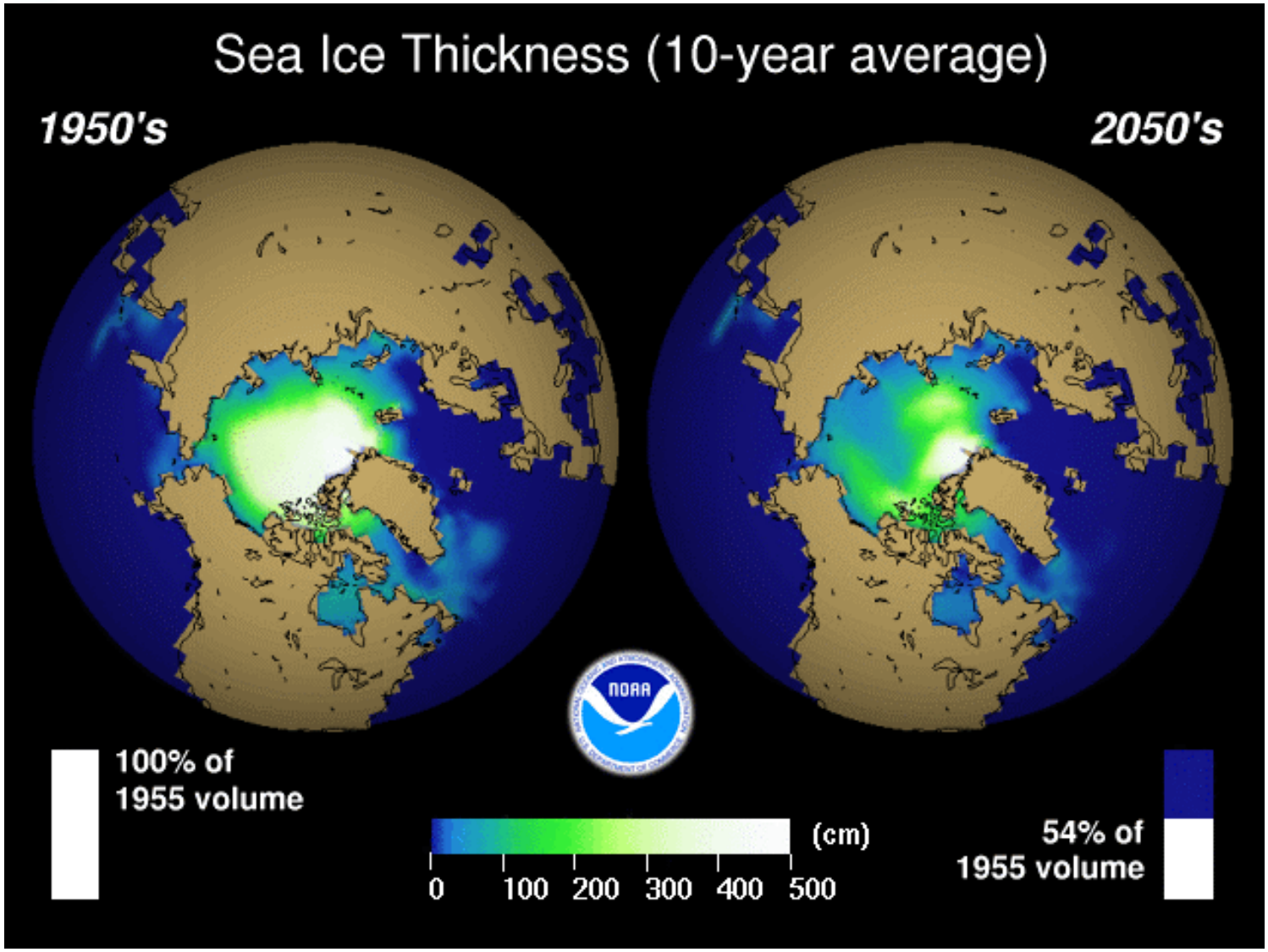
Source: Global Warming Art (2008).

Examples of climate change



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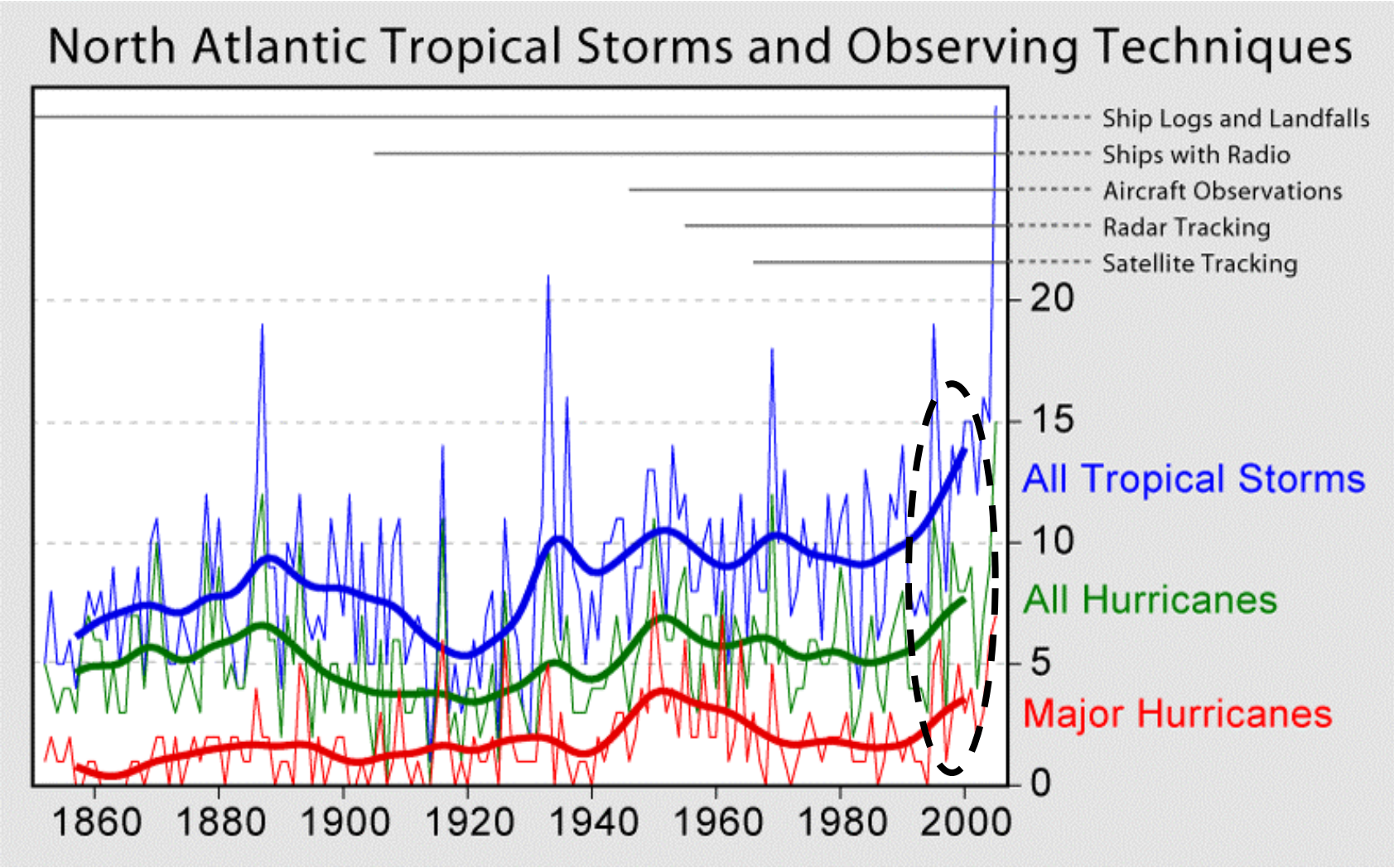
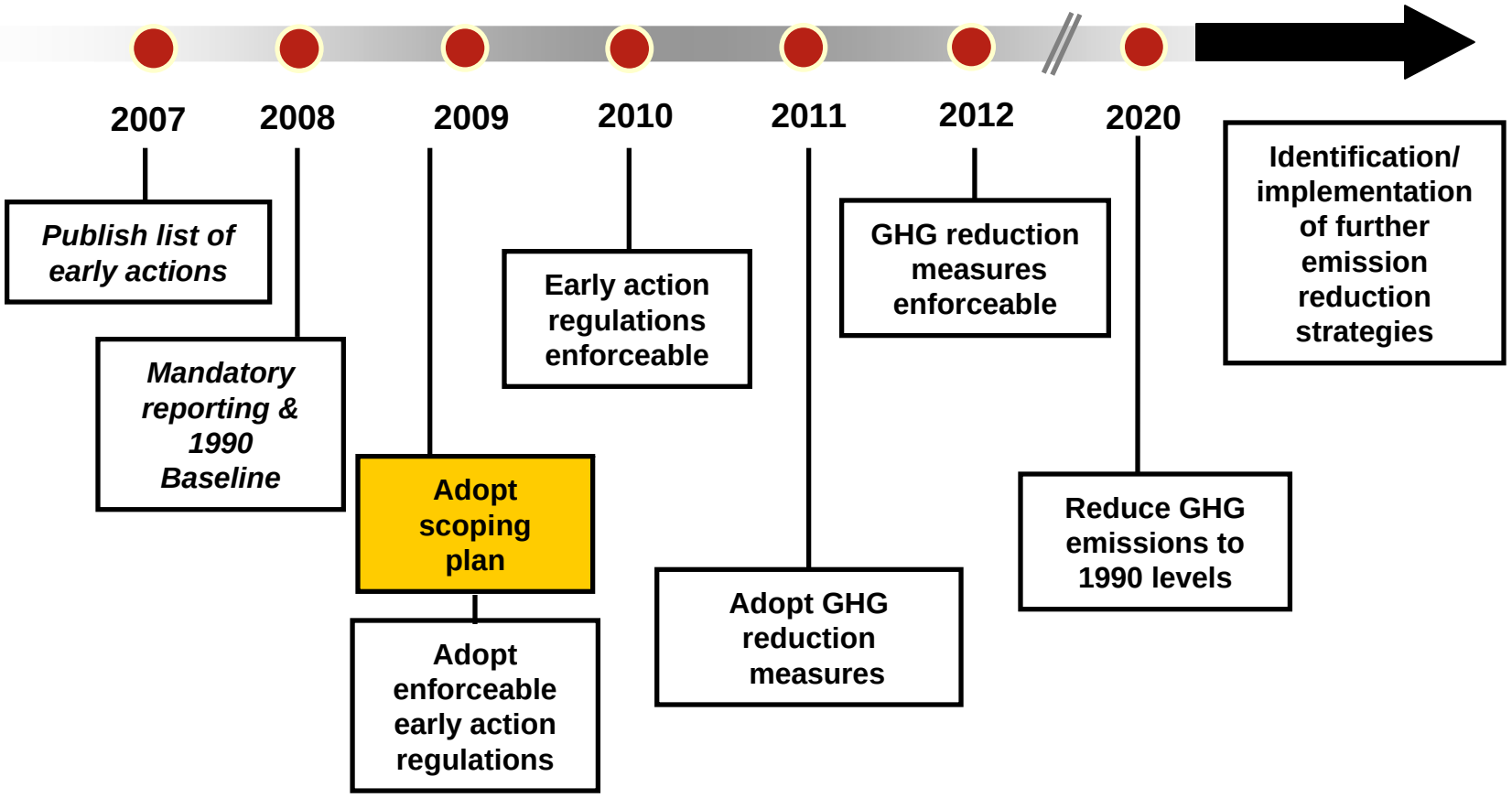
Source: National Oceanic and Atmospheric Administration (NOAA).

Examples of climate change (cont.)

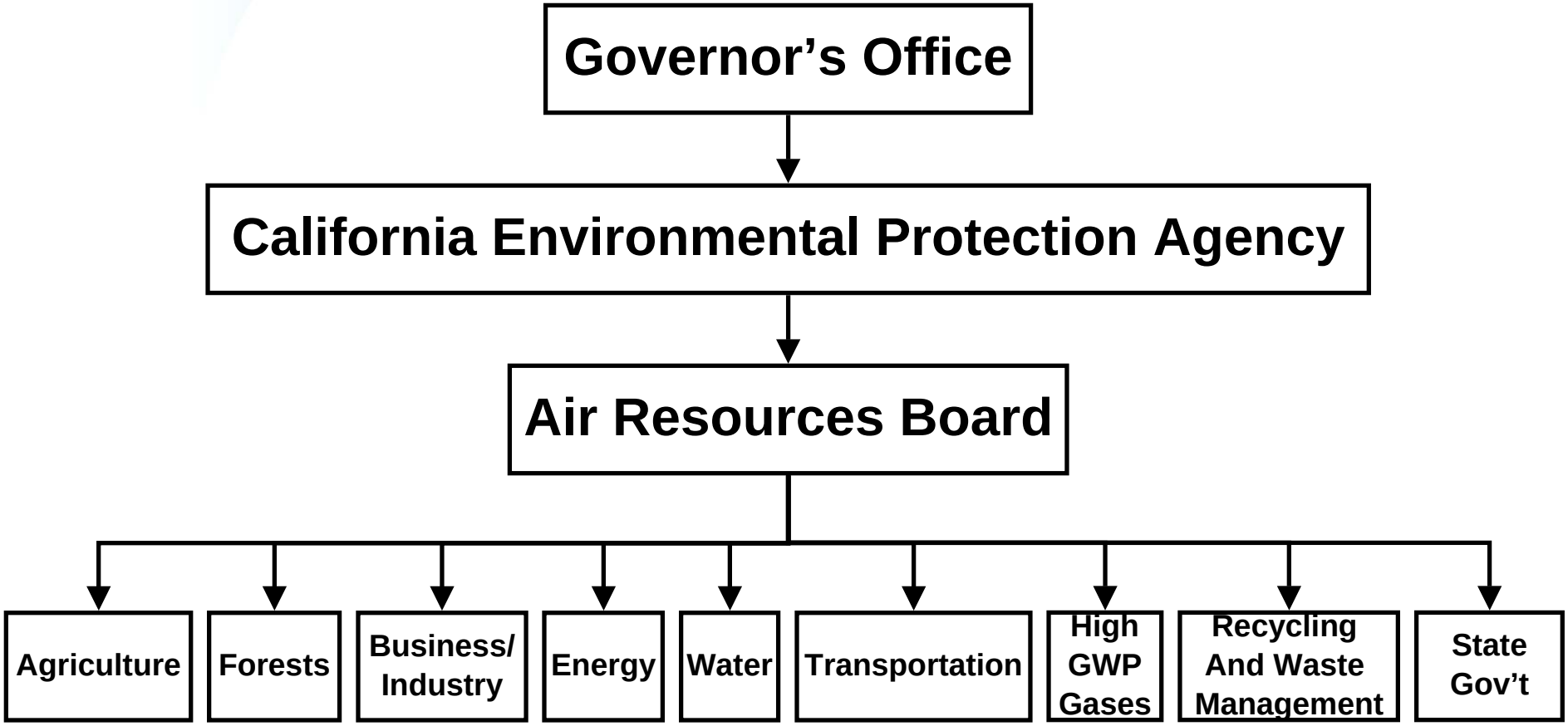


Source: Global Warming Art (2008).

AB 32 overview timeline



CAT relation with the Governor, Cal/EPA and ARB

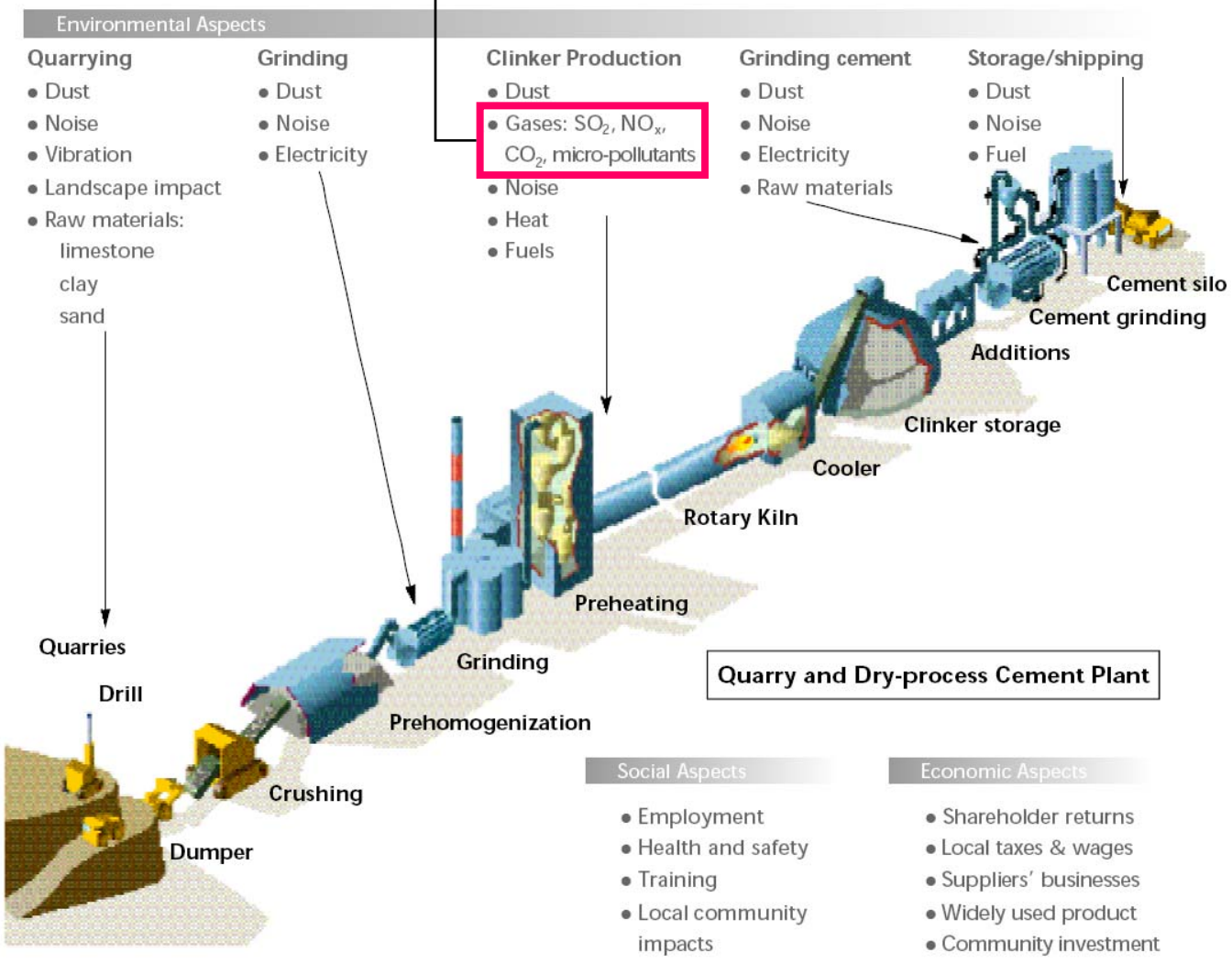


What is our goal?

- Reduce cement and concrete GHG emissions to the 1990's levels by 2020.

Environmental aspects of cement production

Cement sub-group focus: GHG



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Source: World Business Council for Sustainable Development (2002).

How does cement production emit GHG?

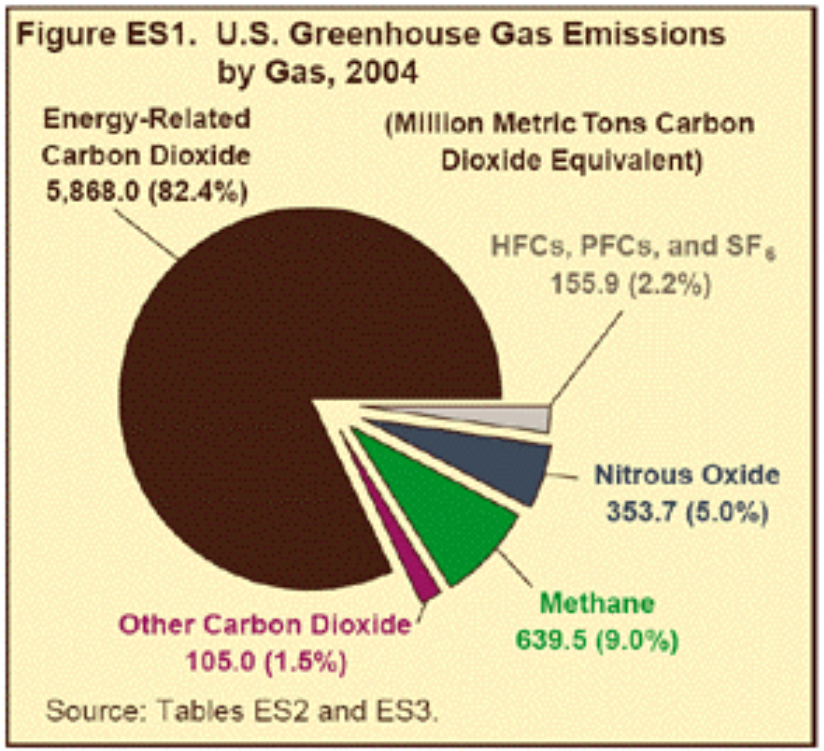
		CO_2 intensity factor ($MMT\ CO_2$/cement)		
		1990	2005	Change
Calcination	$CaCO_3 = CaO + CO_2$	0.52	0.52	0.00
Fuel Combustion		0.40	0.34	-0.06
	TOTAL	**0.92**	**0.86**	**-0.06**

California Climate Action Team Cement Sub-Group

Source: Portland Cement Association (2007).

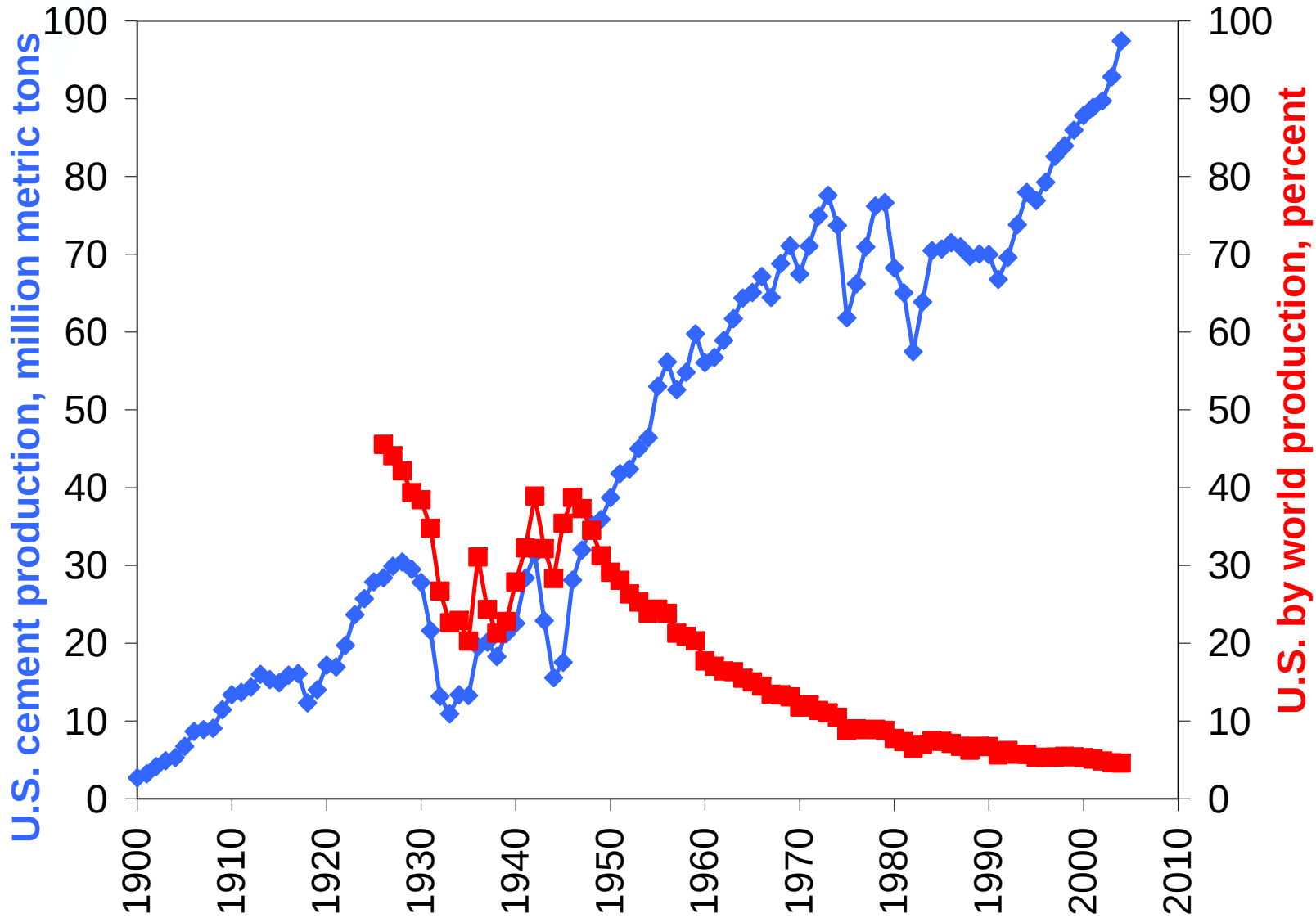
What are the GHG sources?

- Main type of GHG: CO_2.
- CO_2 emissions from cement production:
  - ~ 7% worldwide.
  - ~ 19% in China.
  - ~ **2.5%** in California.
  - ~ 2% in the U.S.



Source: Energy Information Administration (2006).

How has cement production changed?



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Source: U.S. Geological Survey (2006).

What are our strategies?

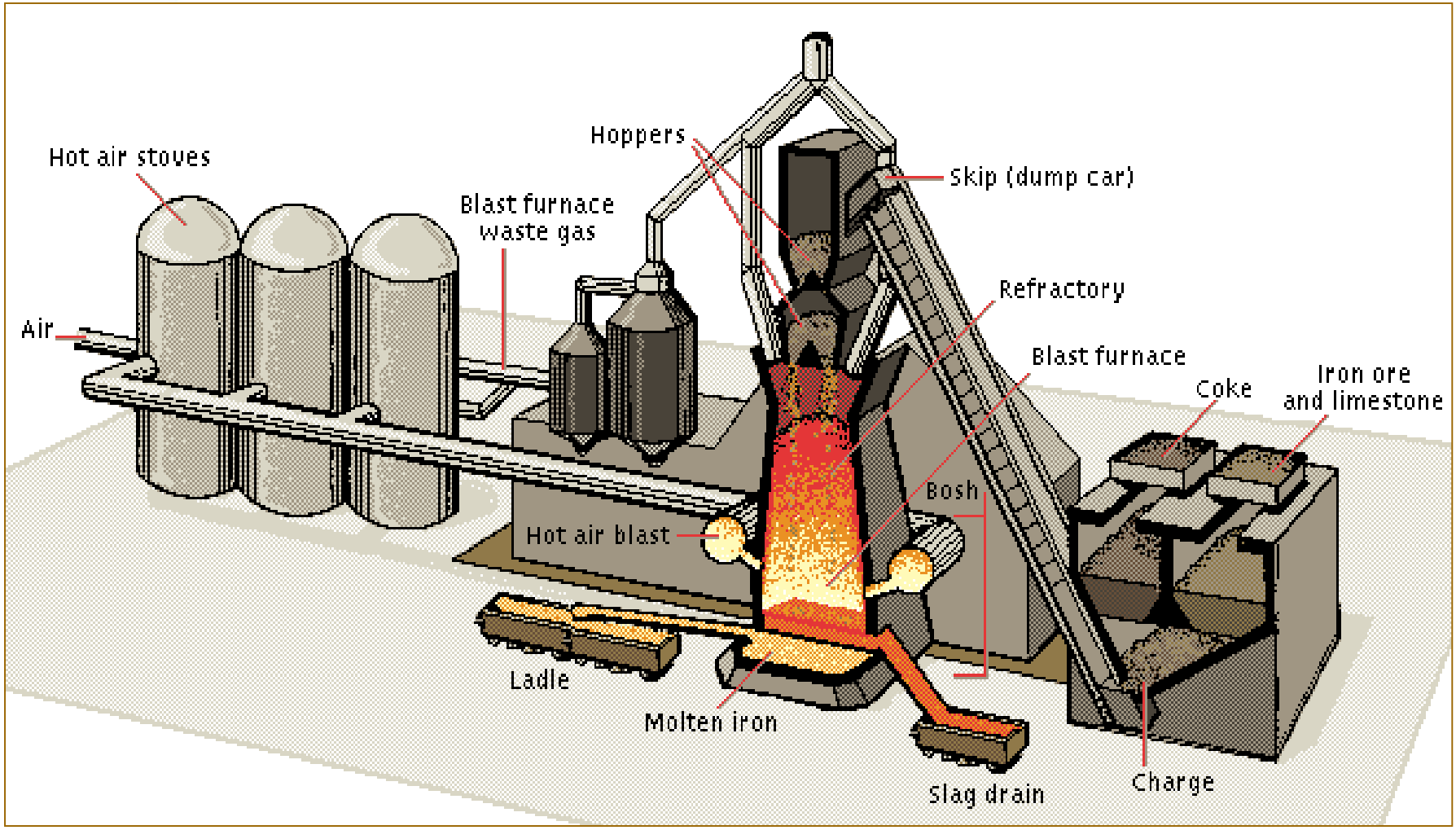
- **Concrete-related:**
  - Replace cement
  - Optimize concrete construction/design
- **Cement-related:**
  - Use environmentally friendly fuels
  - Dilute cement with inert limestone
  - Improve energy efficiency
  - Capture carbon dioxide
  - Universal GHG emission standards

Fly ash: by-product of coal power plant

Notes. Navajo Generating Station located at Page, AZ.
Fly ash class F production: 550,000 tons distributed to UT, AR, NE and CA.

Courtesy: Headwaters Resources.

Slag: by-product of iron production



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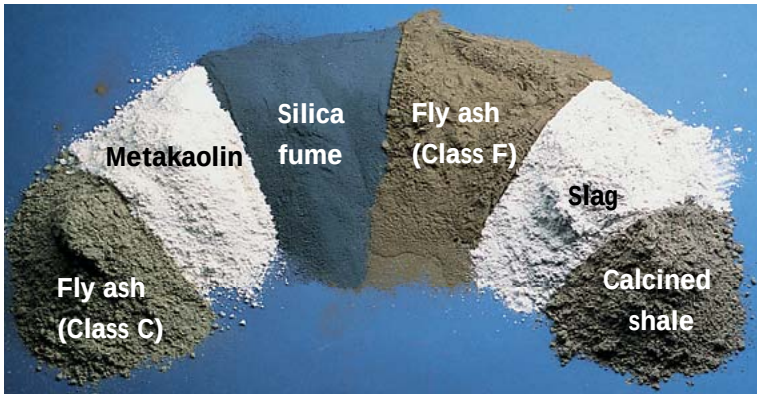
Courtesy: Slag Cement Association.

Cement replacement with SCM

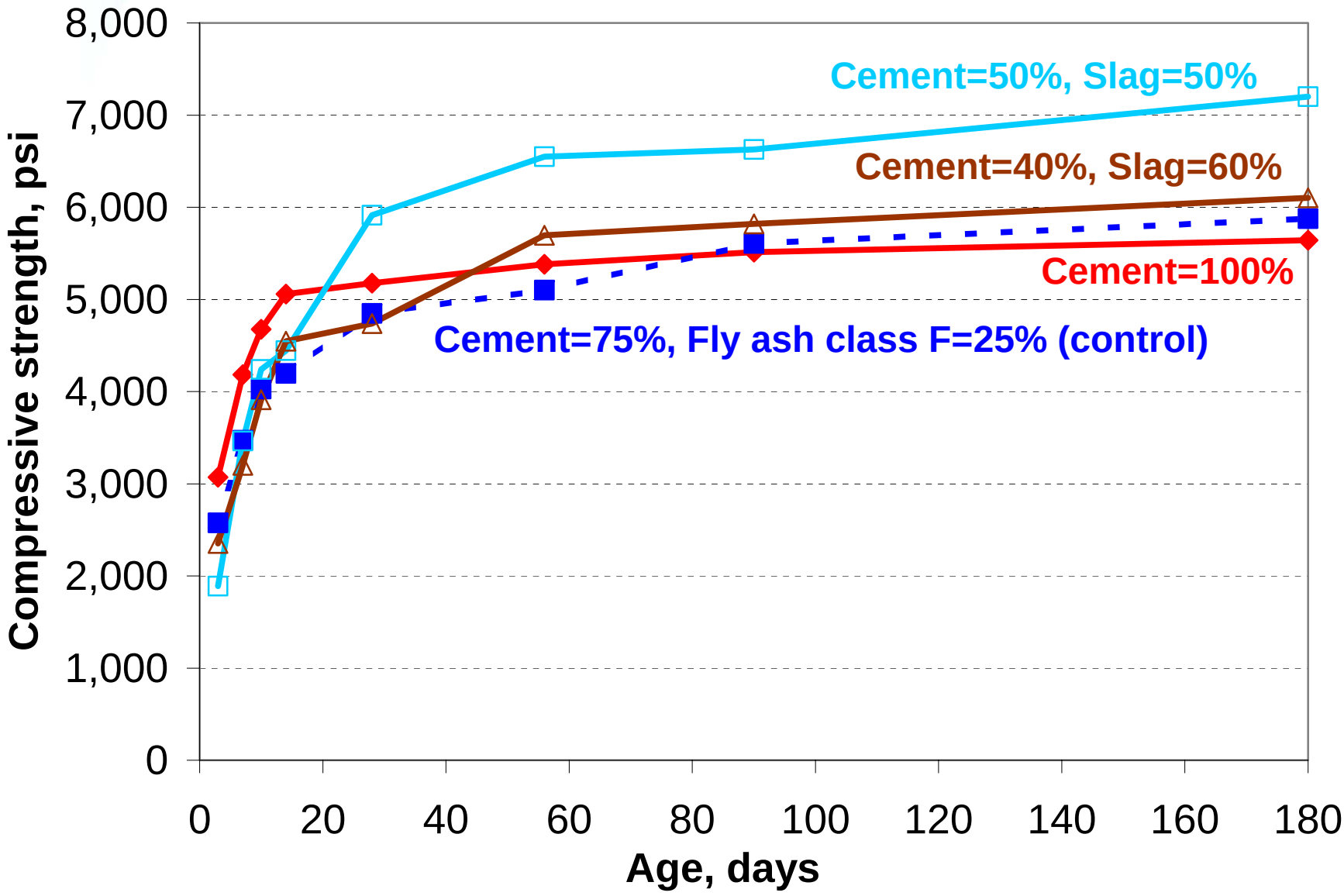
- Cement replacement with **supplementary cementitious materials** (SCM)



- Why SCM?
  - Makes better concrete
  - Doubly environmental benefits:
    - Reduce GHG emissions
    - Use recycled products

Courtesy: Portland Cement Association.

Preliminary Caltrans results of SCM study



SCM amount in SFOBB major elements

Precast lightweight panels: 25% fly ash

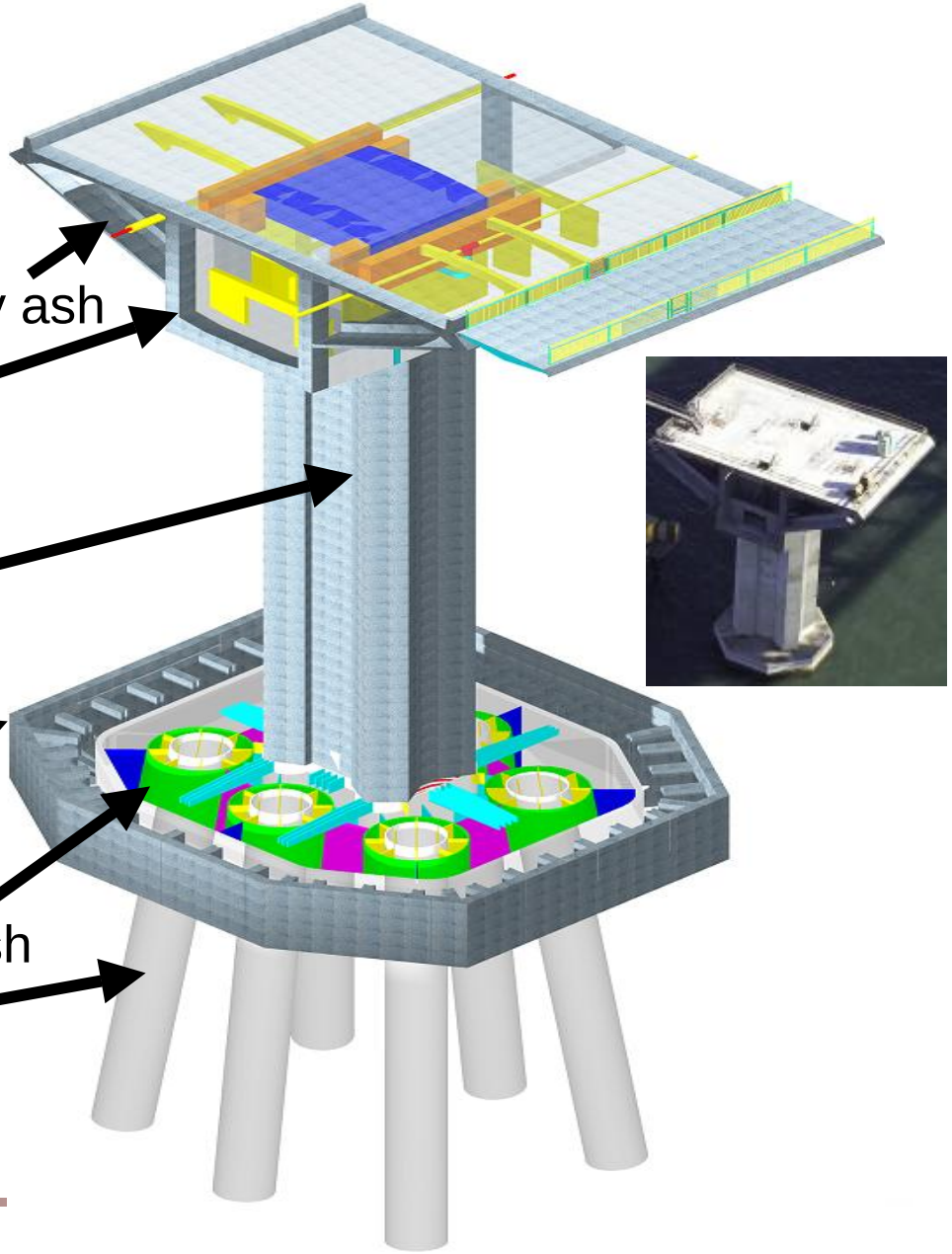
Pier table: 25% fly ash

Pier column: 50% slag

Precast fender: 20% fly ash

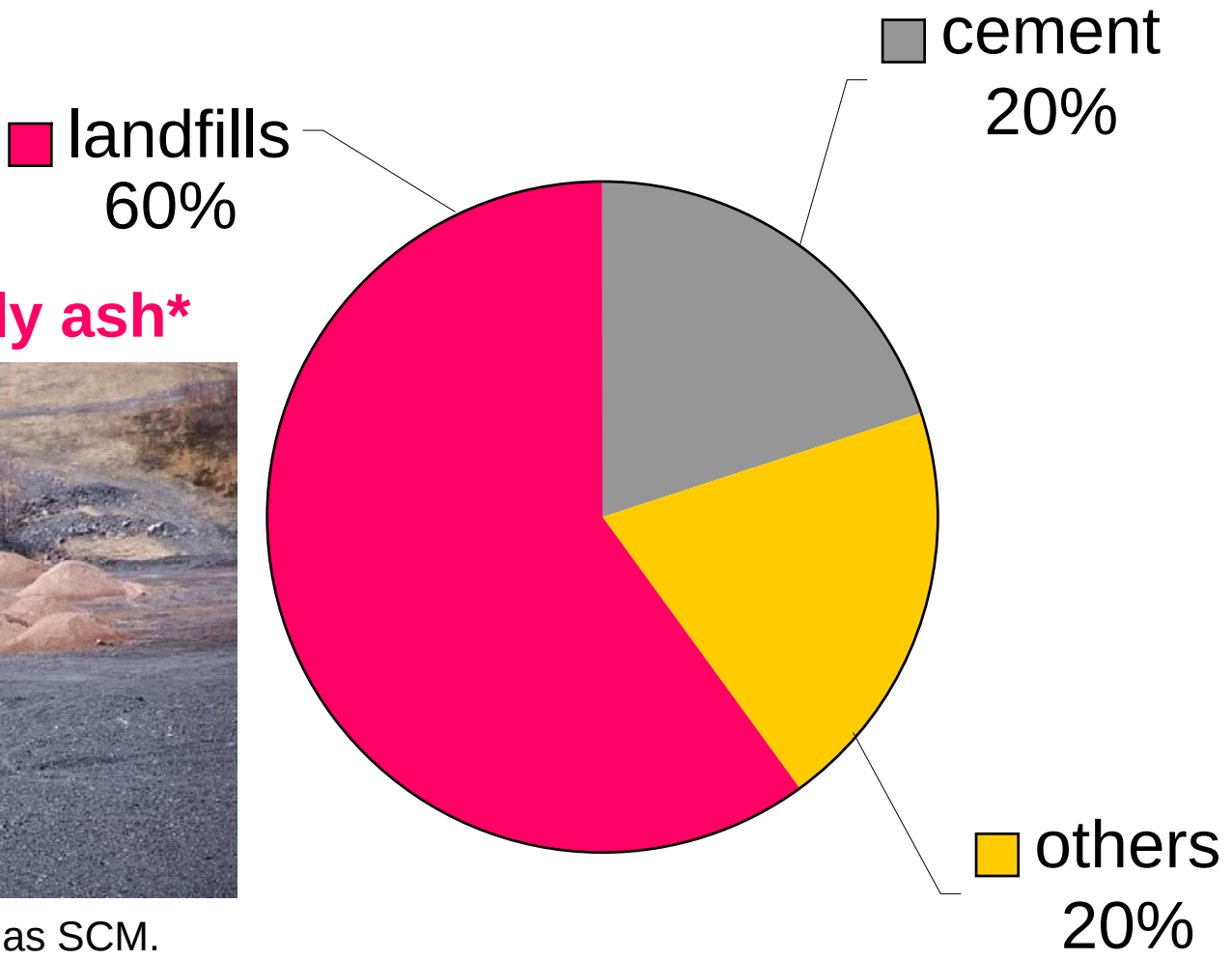
Lightweight footing cell: 60% fly ash

Pile: 35% fly ash



Fly ash usage in 2004

Total production: 70.8 million tons



42 million tons of fly ash*

***Not all can be used as SCM.**

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Source: American Coal Ash Association (2006)

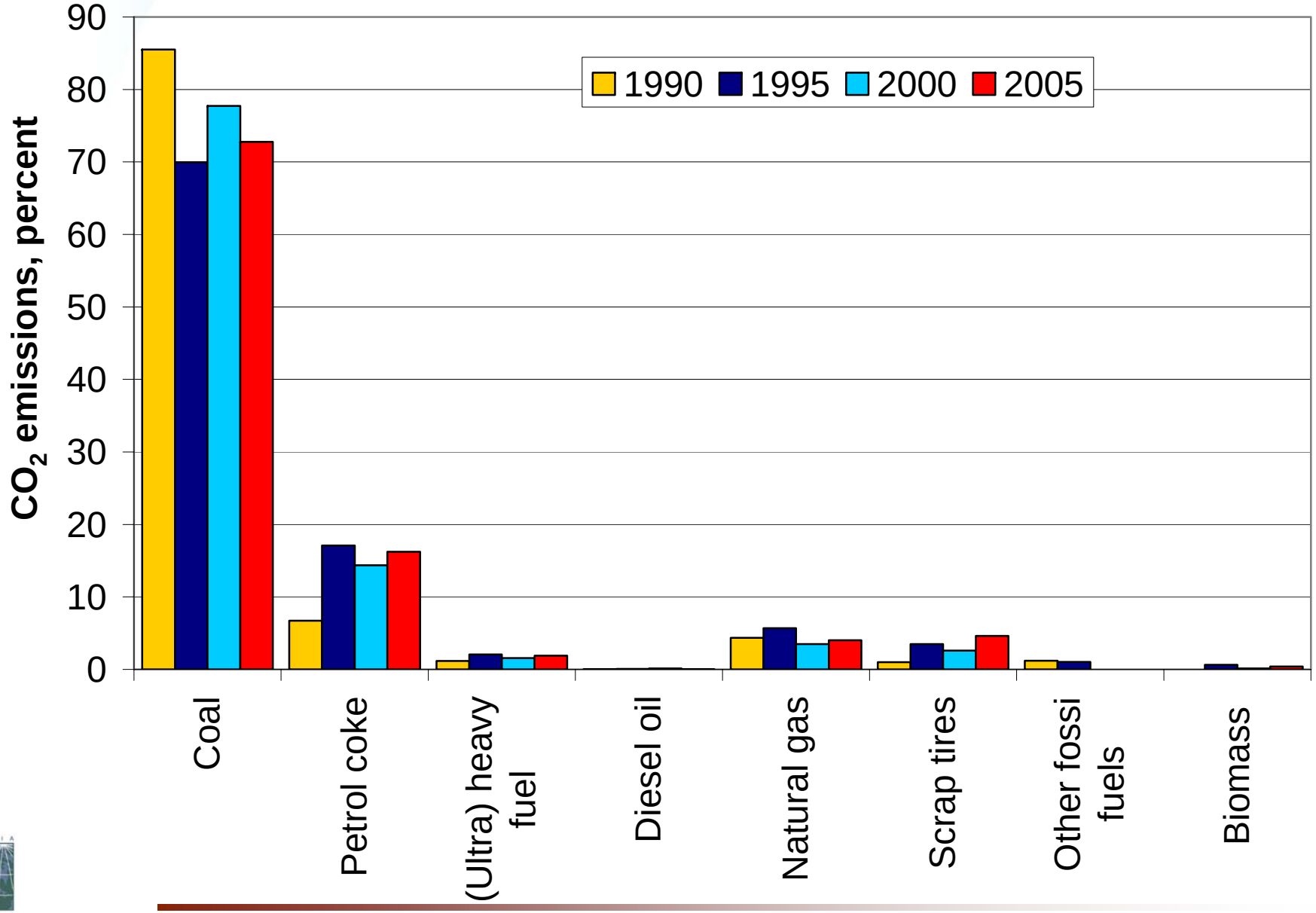
How can we optimize construction/design?

- **Increase design life**
  - **Example:** design 100-year pavements

NO CONE ZONE FOR 100 YEARS

- **Adopt better construction/design practices**
  - **Example:** optimize concrete mix design (use less cement and water)
- **Use environmentally friendly construction techniques**
  - **Example:** use recycled concrete

Cement-related fuel combustion in CA



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Source: Portland Cement Association (2007).

Which fuels should be considered?

- **Natural gas**
- **Biomass**
- **Scrap tires**
  - With such high temperatures inside the kiln, there is no residue from tire burning.
  - Produce lower amount of NOx than coal.
  - Usually limited to about 25% of total fuel supply because contains zinc (slows setting time).

View inside kiln

How much inert limestone should be used to reduce GHG?

- Caltrans recently finished a study to evaluate the effect of limestone on concrete performance.
  - **Conclusion:**
    - Cements tested with limestone had better short-term strength and less permeability, but slightly higher shrinkage (at 90 days).
    - Accept the full 5 percent specified by ASTM C 150 but add shrinkage control.
  - **Action:**
    - Caltrans will work with cement ad-hoc committee to develop a performance-related specification.

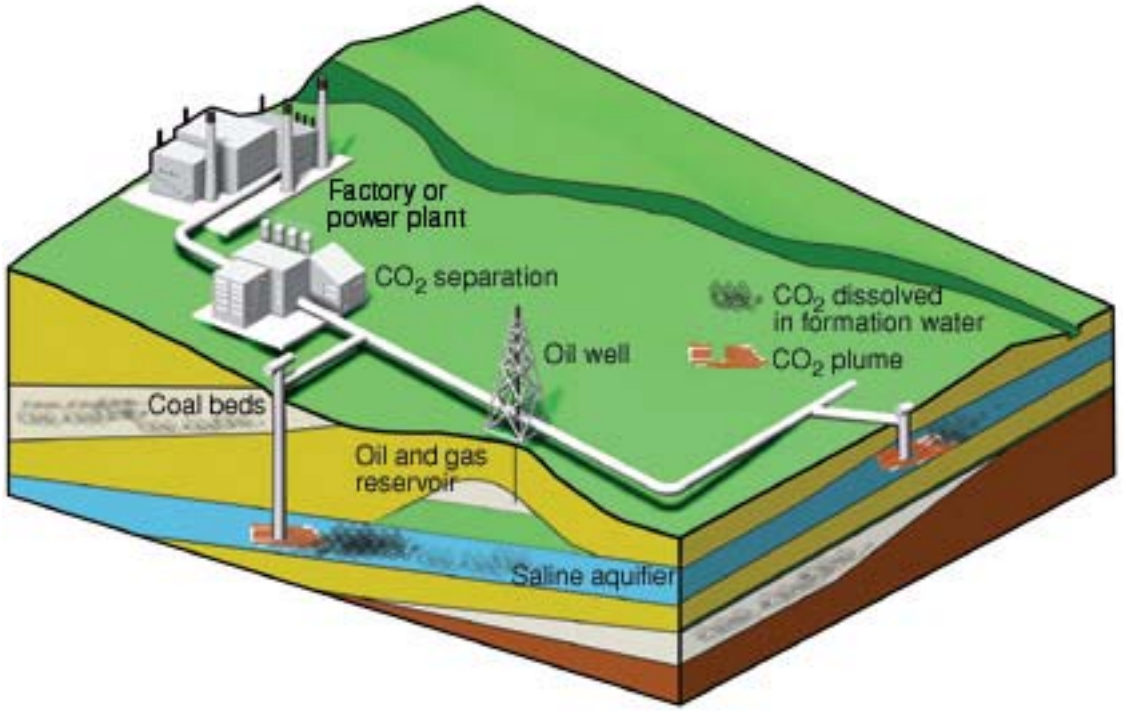
How energy efficiency can be improved?

- **Use precalcinators:**
  - Only one cement plant in CA does not have it.
- **Use of dry kilns:**
  - All cement plants in CA have dry kilns.

- **Reduced number of kilns:**
  - Only one cement plant in CA has multiple kilns.
- **Replace cement with fly ash at the cement plants:**
  - Potential to reduce GHG by at least 25%.

What is carbon dioxide sequestration?

- Technology to capture and inject CO_2 underground developed by U.S. oil companies.
- There are large scale demonstration projects of CO_2 sequestration.
- Potential to reduce high amounts of GHGs.



Source: Lawrence Livermore National Laboratory (2007).

Questions?